Simulation 3 – Project Report

Submitted by:

Rahul Sethi

Masters in Computer Science

Student Id: 200241349

Description:

The objective of this project is to find the 95th percentile and its confidence level of the end to end delay of the packet from video server to the client server.

Technology Used:

The language used to code the simulation: C++. No external libraries are used and everything is made from scratch.

Algorithm:

- The code for the Simulation Project 2 remains intact.
- Modifications:
    - ID was associated with each packed.
    - In all the 3 events packet's time delay was updated using its id.
    - At the end the all the packets delays time were divided into different batches.
    - Mean was calculated for each batch.
    - Then total mean for all the batches was calculated = T_{mean}.
    - Standard Deviation is calculated = s.
    - Confidence interval at 95% is calculated using below formula

$$\left(T_{mean} - 1.96\frac{s}{\sqrt{n}}, T_{mean} + 1.96\frac{s}{\sqrt{n}}\right)$$

Calculations:

Values: N- 90000, DH- 1, DL- 2, Mean service time in the infinite server queue- 10, Mean service time in the client queue- 1.5, TL- 3, TH- 6.

Total No of Packets: 90000

Batch Size: 3000

Total No of Batches: 90000/3000 = 30.

Mean of Batches found:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
13.282	13.283	13.294	13.147	12.966	13.173	12.863	12.857	13.230	13.349
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
13.171	13.138	12.954	13.166	13.197	13.124	13.126	12.936	13.182	12.999
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
13.583	13.108	13.184	13.127	13.336	13.006	13.513	13.274	13.122	13.070

Total Mean: Sum (All Means) / Total No of Batches = 13.1591

Standard Deviation: 0.164767

Confidence Level at 95^{th} Percentile = (13.0991, 13.219)

Observations:

- It was observed that 95^{th} percentile confidence level is almost equal to mean of all the batches.

  (13.0991, 13.219) ~ 13.1591

Validations:

If you set DH = DL = 2, then it is possible to estimate the mean end-to-end delay using queueing theory. In particular, this mean is equal to DH + $1/\mu d$ + the mean time in an M/M/1 queue with $\lambda=1/DH$ and $\mu = \mu q$.

For DH = DL = 2,

- Mean of All Batches = 14.1741
- Confidence Level at 95^{th} Percentile = (13.9483, 14.3999)

Using M/M/1 Queue,

- Mean = DH + $1/\mu d + \rho^2/(1- \rho)$ where $\rho = \lambda/ \mu$ and $\lambda = ½$ and $1/\mu = 1.5$.
- Mean = 2 + 10 + 2.5 = 14.5

We can see 14.1741 and 14.5 are almost equal so our result has been validated.

Graph:

The below graph shows delay time for each packet. Y-Axis represents delay time and X-Axis represents packet number.